

Systems Analysis in Support of the NASA Fuel Cell Upgrade Program for the Space Shuttle Orbiter



Existing alkaline fuel cell power plant for shuttle orbiter.

In early 1996 as part of NASA's overall efforts to improve space shuttle operations, NASA undertook an internal assessment of the shuttle to identify subsystems in the greatest need of upgrading. The criteria used to rank the candidate subsystems were safety improvement, reduction in acquisition and operational costs, improvement in fleet supportability, improvement in mission effectiveness, implementation risk, and commonality with future NASA missions. On the basis of the preliminary results of the NASA assessment, the Fuel Cell Power Plant (FCP) for the shuttle orbiter was among those subsystems selected for further consideration.

The FCP upgrade will involve replacing the existing alkaline fuel cell system with an advanced proton exchange membrane (PEM) fuel cell system. Development of the PEM system for the shuttle will also support a number of other important future space applications. Among these are Moon and Mars surface and transportation power, International Space Station emergency power and/or energy storage, reusable launch vehicle power, and various portable power applications. In carrying out its shuttle FCP upgrade program, NASA is leveraging its own technology development efforts by capitalizing on all of the large-scale PEM fuel cell technology development activities that have been conducted for the Department of Energy, the Department of Defense, and commercial users.

A team comprising members from NASA's Johnson Space Center, Lewis Research Center, Jet Propulsion Laboratory, and Kennedy Space Center has been working on a plan to upgrade the shuttle orbiter FCP. Key elements of the plan include

1. Systems analysis to assure compatibility and the maximum utilization by the shuttle of the best PEM fuel cell characteristics

2. Testing of both short stacks and water separators from the leading PEM fuel cell manufacturers
3. A flight experiment to verify PEM system thermal and water management under zero-gravity conditions
4. Selection of the best PEM system
5. Development of flight hardware for both the power and accessory subsystems

NASA Lewis is leading the systems analysis effort in concert with the Jet Propulsion Laboratory. Important subtasks of this effort include defining conceptual design options, configuring computer models for the design, conducting performance parametric analyses, developing system packaging configurations, and ranking conceptual design options. Data derived from the systems analysis task will help guide both the team and our contractor partners as we work toward developing the flight hardware.

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